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From Porcelain to Synthesis

➤ A LOOK BACK into the past shows that in some places on the face of the earth, as in parts of China, things are being done very much as they were a thousand years ago. This is a contrast to the rush of research recognized through the accolades of the Nobel prizes.

There are truly new things in the world. These are not alone the thousands of new chemicals used as drugs, textiles, plastics and other novel materials. There are new ways of looking at things and doing things. Out of the new patterns of thought, born of science, come these new material fruits of science.

The old, exemplified by the persisting art of Chinese porcelains, described in this issue of CHEMISTRY, is not to be despised and ignored, merely because it is old. The experimental methods, through cut and try and unlearned lore, had their effect in building up early industry, the technology of which is certainly to be admired, even by present-day standards. If this was done over a period of many decades, instead in a few years or even months, as in present industrial practice, that is not too important, for time in those days, at least to us today, seems less urgent than now.

Modern technology is indeed more bountiful in several ways. We get at results faster, thanks to the accumulation of knowledge and the modes of thinking and doing that we practice.

And we produce more for more people. Those fine porcelains of ancient China were for the privileged few, the rulers, those who literally lived upon the backs of the people. What we produce today, thanks to science and technology, applied by industry, is of use to all of us.

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▸ NOBEL PHYSICISTS — *Dr. Willis E. Lamb Jr., now a professor at Stanford University, and Dr. Polykarp Kusch of Columbia University, co-winners of the 1955 Nobel Prize in physics.*

Three Americans Win Nobel Awards

Physics

▸ A COMPLETE restatement of the theory of light resulted from the studies of the two United States physicists who won this year's Nobel Prize in physics.

Dr. Willis E. Lamb, Jr., now a professor at Stanford University, Calif., and Dr. Polykarp Kusch of Columbia University share the top scientific honor for experiments on atomic structure performed at Columbia under Prof. I. I. Rabi, also a Nobel Prize winner.

Although the experiments by the two scientists were entirely separate, they showed the previous theories of atomic behavior needed revision.

Dr. Kusch measured very accurately the magnetic moment, or strength, of spinning electrons for many elements, using the molecular beam method. His careful and painstaking work proved that an electron's magnetic strength is one-eighth of one percent larger than had been thought.

Small as this discovery may

➤ THE WINNER *of the 1955 Nobel Prize in chemistry, Dr. Vincent du Vigneaud of Cornell University Medical College, New York, is shown receiving congratulatory calls in his office. Discovery of a way to make synthetic hormones won him the award.*

seem, it is actually very big to physicists. When combined with results of Dr. Lamb's studies concerning the energy levels of the hydrogen atom, scientists were forced to find an explanation for the discrepancies between theory and observation.

The new Nobel Prize winners' work gave real impetus for changes in the theory put forward by another Nobel Prize winner, Prof. P. A. M. Dirac, Dr. Rabi states.

The difference between theory and experiment found by Dr. Lamb is the relationship of energy levels in the hydrogen atom to states of the electron's motion.

Dr. Lamb's discovery of a change in the hydrogen atom's energy levels is now known among physicists as the Lamb shift.

Chemistry

➤ DISCOVERY of a process for duplicating in the laboratory fundamental chemicals controlling human body functions has won the 1955 Nobel Prize in chemistry for Prof. Vincent du Vigneaud of Cornell University Medical College, New York.

The chemicals Prof. du Vigneaud has already synthesized are two hormones produced in the body by the pituitary gland. This nut-sized structure at the base of the brain has been called the body's master gland. It is perhaps best known to the layman as the source of ACTH, famous for its anti-arthritis action.

Oxytocin was the first pituitary hormone synthesized by Prof. du Vigneaud, and the first hormone of this gland ever to be synthesized. It gets its name from the Greek word for "rapid birth." Its action in the body is two-fold. It causes the uterus to contract in child-birth and it influences release of milk from the mammary glands of the mother.

Second pituitary hormone Prof. du Vigneaud synthesized is vaso-

pressin. This blood pressure-raising, antidiuretic hormone is of prime importance in the treatment of diabetes insipidus and the diagnosis of epilepsy.

The basic chemical work which led to discovery of the structure of these hormones and then to their synthesis was begun in 1932 while Prof. du Vigneaud was on the faculty of George Washington University in the nation's capital, and continued there for six years before he was called to Cornell.

During World War II this work, under way at Cornell, was interrupted while Prof. du Vigneaud worked on the chemical mystery of the then scarce and vital penicillin. Late in 1946, after 38 groups of scientists had been working on the problem for years, Prof. du Vigneaud succeeded in synthesizing the famous mold chemical.

Prof. du Vigneaud was quick to point out that "many, many people" had participated with him through the years in the researches for which the award was made.

Medicine

▸ RESEARCH on a horseradish chemical and on blood are included in the studies for which the 52-year old Swedish biochemist, Prof. Axel Hugo Theorell (pronounced Tee-o-rell), won the 1955 Nobel Prize for medicine.

The horseradish chemical is peroxidase. This enzyme catalyzes, or sparks, the transfer of oxygen from hydrogen peroxide or other peroxides to another substance. The horseradish peroxidase is a hemoprotein.

Prof. Theorell and associates achieved the reversible splitting of it into hemin, a chemical related to the red color chemical of blood, and protein. Then Prof. Thorell put the two parts together again, getting a preparation with the same enzyme action as the original horseradish peroxidase.

Before his work on the horseradish chemical, Prof. Theorell won fame for separating blood components by electrophoresis. He demonstrated this at a physiological congress in Leningrad in 1935.

Much of his scientific work has been on enzymes that have a central and prominent part in the respiration process by which the body cells get and use oxygen. Recently he has been stressing the important role of chlorine in connection with another respiration enzyme, cytochrome.

Prof. Theorell is considered the leading biochemist in Sweden.

He is a stocky man who walks with quite a limp. Music and boating are among his hobbies. The boating apparently is done on a large scale since he is said never to think "of any boat less than 50 feet." He plays the violin and piano. His wife teaches piano

and is harpist with the Stockholm Symphony Orchestra. He is on the orchestra board of directors.

Prof. Theorell is head of the Medical Nobel Institute at Stockholm and is said to be the chief selector of Nobel Prizes in biochemistry. Every year he goes off on an island and spends a month there reading research reports by candidates nominated for that year's prize.

He is also believed to have helped save another Nobelist, Prof. Albert Szent-Gyorgyi, from the Nazis in Budapest during the war. Prof. Szent-Gyorgyi found shelter in the Swedish Legation in Budapest where he was employed as a chauffeur before his escape to Moscow and eventually to the United States.

New Atomic Light Source

➤ THE NAVY is testing an "atomic" phosphorescent light source that can burn continuously for years without electricity or batteries.

With it, a sailor can read maps, orders and instructions in total darkness when ordinary light is not desirable or available. The light burns continuously from the energy of radioactive strontium-90 particles bombarding phosphors, which are chemicals made to glow as those in luminous watch dials.

Night fishermen, campers, ushers and car owners may find such a lamp useful, if they become available commercially. In mass production it is estimated that the lamps would cost only a few dollars each.

A lamp that gives light ten times as bright as moonlight on a clear night has been made. Even a hand light one-sixth as powerful as this would enable a person to find his way around in the dark, Dr. L. J. Boardman of the Naval Research Laboratory's optics division said.

Use of radioactive isotopes to excite the phosphors is seen as a way to eliminate cumbersome power sources and electrical equipment in some military applications.

Phosphor lamps have been created that give off a variety of colors, but green and yellow-green seem the brightest to the observer and are the only colors being considered.

There is a radiation danger and caution must be taken in handling the phosphor lights. They contain radioactive strontium-90, but an effective cover design for the lamp and care in using the light would completely eliminate the problem, Dr. Boardman said.

Make Active Virus From Inactive Chemical Parts

Live Virus Synthesized

➤ A MAJOR MILESTONE in the fight against virus diseases and a step toward the synthesis of such key life chemicals as chromosomes, the controllers of inheritance, have been reported by two University of California scientists.

In a paper in the Proceedings of the National Academy of Sciences, Drs. Heinz L. Fraenkel-Conrat and Robley Williams described experiments of far-reaching impact in science. These scientists claim that their work is the first partial synthesis of a virus.

It is the first time a self-duplicating system (a property usually attributed to living things) has been assembled in the test tube from inactive materials, the California scientists state.

It is the first time inert fragments of viruses have been put together to form active viruses capable of causing rampant disease.

In their experiments, the scientists separated tobacco mosaic viruses into their two main component chemicals, protein and nucleic acid. They tested the two parts, and determined that neither could cause infection. Both were inactive.

Dr. Fraenkel-Conrat, by chemical means, was able to obtain virus nucleic acid that was seemingly undamaged, a feat not previously achieved. After the two components were put together, viruses were reformed. Not only was the activity of the reconstituted viruses shown by infection of tobacco plants; in addition, electron microscope photographs showed that the recombined viruses had been formed from fragments of the two original components, the scientists explain.

The work opens up several approaches to an attack on virus diseases, as well as new investigations of some of the most basic biological problems, Drs. Fraenkel-Conrat and Williams point out.

First, it may be possible to "tailor" viruses by breaking them up and then recombining them in ways slightly different from the original. Such "tailor-made" viruses might give immunity but be incapable of causing disease.

Second, virus antigens might be developed, using virus fragments. Antigens stimulate the production of anitibodies, which in turn fight disease. Fragments of viruses, like those observed in the electron microscope, might bestow immunity to the whole virus.

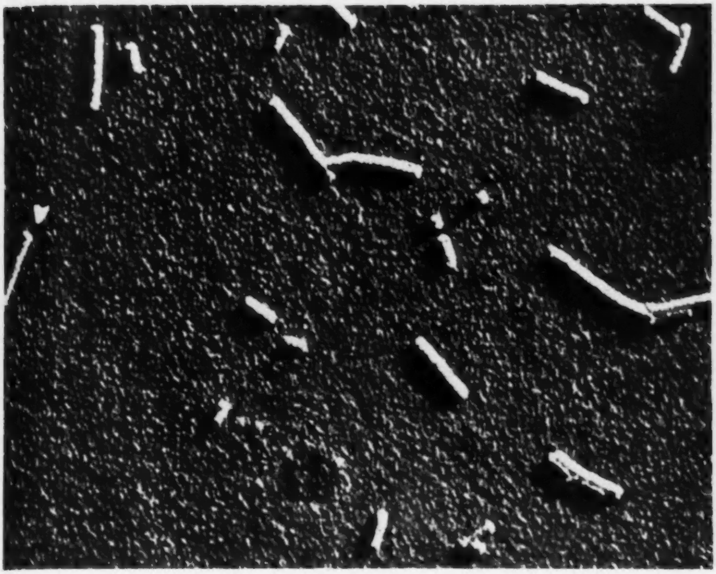
Along other lines of investiga-

➤ SMALL FRAGMENTS *of the protein fraction of tobacco mosaic virus as seen by the electron microscope at the University of California. Close inspection shows these are doughnut-shaped. Their molecular weight is about 400,000. These fragments, Drs. Fraenkel-Conrat and Williams have found, cannot cause disease.*

tion, the research offers an important avenue for the study of heredity in all living things. If one self-duplicating system can be made from inert material, it may be possible to reproduce other self-duplicating systems, such as chromosomes, the carriers of hereditary characteristics.

Another possibility is the eventual synthesis of viruses themselves. Dr. Wendell Stanley of the University of California, director of the Virus Laboratory, in which the work was done, said that fragments of about 20,000 molecular weight are within the range of chemical analysis of structure and ultimate synthesis. Fragments of this size are found in the broken viruses. It might be possible to make such fragments combine into another grouping of fragments in the 100,000 molecular weight range. These are the ones that go together to reconstitute the viruses.

The scientists also said the



▸ LONG RODS *which are actually rebuilt, disease-producing viruses. The rods are protein, and were formed, in experiments by Drs. Fraenkel-Conrat and Williams at the University of California, from the doughnut-shaped fragments in the photograph opposite. Down the center of the rods, but invisible, run strands of nucleic acid, the second fraction of the virus.*

work may have some psychological effect on scientists themselves. Viruses have been held in a certain awe by scientists because they possess properties of living things. When made out of inert materials, viruses would become more than ever a problem of arrangement of chemical components.

In August, similar results were obtained in St. Louis and mentioned in September at the meeting of the American Chemical Society in Minneapolis as an addition to a paper by Dr. Barry Commoner of Washington University, St. Louis.

The California team's first evidence for recombination of the virus was obtained in March of the present year. The research was supported by the National Foundation for Infantile Paralysis and the U.S. Public Health Service.

Highest Man-Made Cloud
Formed From Sodium Vapor

Sodium Vapor Test Brilliant in Upper Air

➤ THE HIGHEST cloud ever made by man, a mile-wide, 30-mile-high, orange-red "C" in the twilight sky, was formed by an aerobee rocket spewing sodium from 40 to 70 miles above the earth's surface at Holloman Air Development Center, New Mexico last October.

It left a trail like that made by a jet fighter, but much wider, brilliantly colored and longer lasting. The 30-mile column of sodium vapor was visible within a 300-mile radius of the Air Force's research center.

John Bedinger, scientist in charge of the experiment, said the project was a complete success scientifically.

"Every instrument worked properly, and there is no doubt the radiation we measured was emitted by sodium atoms," he stated.

Such a bright sodium vapor trail has never been seen before, Mr. Bedinger said. It was so intense, the photoelectric instrument scanning it from 9,700-foot Sacramento Peak, 12 miles away, was thrown off scale.

The experiment was a joint project of Holloman Air Development Center and the Air Force Cambridge Research Center, Cambridge, Mass., where Mr. Bedinger is stationed.

It had no direct connection with launching an artificial satellite, although some scientists have suggested this method of making an earth-circling moonlet more visible. The experiment shows this idea has worked.

Sodium atoms in an excited state caused the glowing 30-mile column. (They also give the light of sodium vapor street lamps.)

Although it was twilight on the ground when the aerobee shot from its tower, the sun was still shining 40 miles up where the first flash of vaporized sodium was seen.

Four pounds of the metal was shot out of its two vaporizers. The glowing sodium was still visible to the naked eye 28 minutes after firing. Sunset gradually obscured the column, the lower clouds disappearing first. Some turbulence could be seen.

Preliminary observations indicated the lower part of the vapor was carried eastward at a speed no less than 150 miles per hour, the middle portion stayed put, and the top part went westward.

To a ground observer, the giant "C" was written in orange-red in the sky.

Aim of the experiment was to learn more about the earth's atmosphere, the proportions of the elements composing it and some of the chemical reactions at high altitudes.

Scientists had calculated this information by theory. But actual measurements were needed to make sure the computations were correct. The trail's brightness and persistence exceeded the most optimistic expectations.

About 1,200 pounds of rockets and instruments were required to get four pounds of sodium to the 40-to-70-mile altitudes. There, the sodium was thrown out at a temperature of 2,500 degrees Fahrenheit.

TB Germs Tool to Study Artery Clots

➤ THE TUBERCULOSIS germ has been elevated from the role of death-dealer to that of a new tool to fight dangerous bleeding and the clots that sometimes plug arteries in the heart, lungs and other parts of the body.

This new role for the tuberculosis germ, or bacillus, was announced by Drs. Alfred L. Copley and Trajan Balea of the International Children's Center and Research Laboratories, National Blood Transfusion Center, Paris, France, at the Tufts College meeting of the American Physiological Society.

The TB germ will not be used directly to stop bleeding or to dissolve blood clots. Its use for fighting these killing conditions will be as a new tool for studies of them.

This is foreseen from discoveries which promise also to lead to better understanding of tuberculosis.

The primary reaction of the body against blood stream invasion of TB germs is not, as is generally held, a mobilization of the body's scavenger cells, the phagocytes, Drs. Copley and Balea declared.

Instead, the primary reaction is the formation of plugs in arteries and veins. The plugs, or thromboemboli as they are known technically, are made up of blood platelets stuck together with the TB germs. Subsequently, the walls of small blood vessels called capilaries suffer changes.

These hitherto unknown findings, the scientists reported, offer new guides toward better understanding of the tuberculosis disease and establish the tubercle as a new tool for studies on hemorrhage and thromboembolism.

Cobalt 60 is an unstable form of the element made by prolonged exposure of stable cobalt 59 to neutrons in a reactor.

Atomic Fusion Throws Light
On Evolution of Universe

Fusion Reaction Possibilities Explored

➤ FUSION of atomic hearts, the reaction which releases energy in the H-bomb, powers the building up of chemical elements in the stars. Evolution of stars, from fiery youth to cold and shrunken age, is believed by astronomers to be accompanied by fusion synthesis of heavier elements from the light gases hydrogen and helium.

New chemical understanding of how light elements can build up into heavier ones has been offered the scientific world by Dr. W. A. Fowler, Fulbright scholar on leave from the California Institute of Technology, working in the Cavendish Laboratory, Cambridge University, England, with Dr. G. R. Burbidge and E. Margaret Burbidge.

The new theory supplements the so-called "carbon stove" reaction described by Dr. Hans Bethe, which was the first adequate scheme to account for the known phenomena of solar radiation. The British research applies information about isotope transformations, learned in recent studies of fusion reactions, to the problem of how the stars can build up heavy elements. The question of whether matter is continuously being created out of energy or whether the elements are merely evolving out of some form of primeval matter is not considered by Dr. Fowler and the Burbidges, whose studies of stellar evolution appeared in the *Astrophysical Journal.*

Continuous transformations which will build elments as heavy as magnesium, 12th in order of atomic weight, are described and a possible scheme of evolution of stars consistent with a series of such transformations is given. Heavy elements, according to this scheme, would be formed in stars which have reached the stage described as "cool giants." Matching the stars' places in chemical classification with their types as classified by astronomers may show whether unusual kinds of stars are young or old in cosmic time.

Future Atomic Fuel

➤ TODAY'S unused materials will become the atomic power sources of the future as soon as the key reaction to the fusion process is found.

The problem in using the nuclear fusion process is to control, to maintain and to confine the light-weight elements in such a way that more useful power can be obtained from their reactions

than is expended getting them to react.

The present status of thermonuclear research in the United States was revealed by Chairman Lewis L. Strauss of the U. S. Atomic Energy Commission recently, along with the fact that research programs on fusion are being conducted in this field at five laboratories.

Scientists at Princeton University, at New York University, at Oak Ridge, Tenn., and at the Atomic Energy Commission's laboratories operated by the University of California at Los Alamos, N. Mex., and at Livermore, Calif., are working on the problem of getting energy from the fusion reaction, the kind of thermonuclear reaction which furnishes the heat of the sun.

Two kinds of atomic reactions are potential sources of nuclear energy. The fission reaction, the first of these discovered, powers the atomic bomb made from heavy elements. It acts by splitting the nucleus of the heavy elements, uranium 235 and 233, and plutonium by means of neutrons. More neutrons are given off when the nucleus splits, sustaining the chain reaction which keeps splitting more atoms of the uranium fuel. The reaction proceeds very fast in the atomic bomb, but may be made to proceed slowly in a controlled way in a reactor built to furnish useful power. Such power reactors are just coming into commercial use.

The fusion reaction, which occurs when nuclei of light elements are made to join as in the so-called hydrogen bomb, has not yet been brought to the controlled stage in which it can be made to pay off in useful power, the A.E.C. assures the nation.

Many promising possibilities are being investigated, but the one best way to adapt the fusion reaction, which stokes the stars, to earthly use is still being sought.

Elements at the two ends of the list, available for the two kinds of nuclear reactions, are limited in number. At the heavy end of the list of elements, only thorium and uranium are available in nature for fuel for the fission reaction. Man-made plutonium, one of the A-bomb ingredients, is formed from uranium and is therefore limited by the amount of uranium on earth.

Among light elements, a slightly larger number are possibilities for fuel for the atomic fusion reaction. Hydrogen and helium, the two lightest elements, have been widely suggested as probable fusion elements. Hydrogen occurs in three forms, including "heavy hydrogen," or deuterium, and the radioactive tritium. Similarly, two isotopic forms of helium are known.

The fact that these light elements are gases would seem to make it difficult to "control,

maintain and confine" them as atomic fuel. Hydrogen in any of its three forms could be made more available by combining it with some other element. Helium, since it forms no compounds, would not be capable of this kind of modification.

Next heavier than these gases are two metallic elements, lithium and beryllium, both theoretically capable of taking part in the fusion reaction. Heavier than these are boron, carbon and nitrogen. Boron is the famous neutron absorber which "scrams" the uranium reactor, absorbing and cutting down the supply of neutrons to stop the chain reaction. So far as is known, this property would unfit boron to be a possible fuel for the fusion reaction as well. Carbon and nitrogen take part in the fusion reaction in the stars, but do not seem available for peaceful fusion on earth.

For terrestrial reactors the probable fuels are lithium and beryllium. Both are "today's unused materials." Both combine with hydrogen to form salt-like substances, giving the possibility of doubling the fuel-element charge in a fusion reactor. From a chemical standpoint, these two light elements seem most promising. The A.E.C. is just not discussing them in any way. This makes lithium and beryllium seem even more important in the fusion mystery.

When and if fusion powers the world, it may give atomic power of greater safety than the fission power plants now being built. Neutrons escape when fusion reactions take place, just as they do in fission reactions, but the dangerous radioactive fission products are not formed in the reaction fueled only by light elements.

Atomic Insurance

➤ TAKING Government out of all business except the insurance business on atomic reactors was advocated by Francis K. McCune, vice president and general manager of the atomic products division of General Electric Co., speaking at a luncheon at the First U.S. Trade Fair of the Atomic Industry held in Washington.

Atomic energy reactors for the European market will give U.S. industry a "shot in the arm," for the European market is "wide open right now," Mr. McCune stated.

"But," he added, "it is imperative that information not be just declassifiable, but positively unclassified."

It is not reasonable, he believes, to sell a European a reactor but keep secret the information he needs to run it.

The people of Europe are not lacking in scientific understanding, Mr. McCune emphasized. What they lack, which the United States industries can give them, is experience and experienced

people. As they learn the complex business of atomic power, they expect to apply their own abilities to further development of reactor technology. But the time interval will allow U.S. industry to prepare itself to meet the "tremendous market coming up."

Insuring against the chance of a potential devastating disaster is too great for one insurance company to underwrite, even though such a disaster is extremely unlikely. The General Electric Co. executive believes, therefore, this phase of the new business of atomic energy should be undertaken by the Government, in the same way that it undertook War Risk insurance.

The Trade Fair of the Atomic Industry was held in connection with the Annual Forum on Commercial and International Developments in Atomic Energy. Many of the exhibits were brought back from the international exhibit held at Geneva in August, to give Americans a chance to see the latest commercial developments in materials and instruments for atomic power. Some of the material shown at the "little Geneva on the Potomac" were later shown at other cities in industrial parts of the United States.

Scientist Needs Tears

"WEEP no more, my lady," wrote Stephen Foster, and popular song writers ever since have been admonishing us not to cry.

But if you have any surplus tears, Dr. Robert Brunish of the University of California at Los Angeles Medical Center could use them in his research.

Dr. Brunish is studying the chemical structure of tears as a possible clue to the elusive eye irritant in smog and to learn something of other factors involved in shedding tears. The research is being supported by the Estelle Doheny Eye Foundation.

The U.C.L.A. scientist reports he had little difficulty in getting children's tears. They flow profusely for science from his own children and from the children's ward in the U.C.L.A. hospital. But adults do not cry readily for science, so he is short on grown up tears.

Tears are not just drops of salt water, according to Dr. Brunish. They are a complex solution with a surprisingly high protein content. Apparently tears shed in pain, sorrow or anger differ from those prompted by peeling an onion or those caused by smog and other irritants. It is hoped that these differences may be detected and furnish some clue as to the nature of the irritant in smog.

Yearly Increase Marks Radioisotope Utilization

Isotopes in Technology

Part 2.

➤ THE IMPORTANCE of isotopes is perhaps best indicated by the rapid and continued growth in utilization. Radioisotopes were first distributed from reactors in the U.S.A. in August 1946. Growth and extent of use during the now 9 years' distribution can be expressed in terms of users, shipments, curies, and published papers.

In the first year of radioisotope distribution only about 100 U.S.A. institutions received shipments. In 9 years this number has grown to over 2700. About 1100 are medical institutions and 1200 are industrial firms. Most of these institutions have several groups of users, hence the total number of radioisotope using groups is around 5000.

Most striking is the recent growth in industrial users. In 1950 only about 100 firms were using radioisotopes. The number has increased 12 fold in just 5 years. This in itself demonstrates the importance of isotopes in technology and industry. Industrial firms would not invest in necessary equipment as well as buy the isotopes (sold at full recovery costs) unless the values received were worthwhile. Extension of routine industrial uses of isotopes, such as radiography and radioisotope gaging, are taking place rapidly throughout industry. Also with new applications continually being developed, a continued rapid increase in industrial use is expected.

Radioisotope shipments from Oak Ridge National Laboratory alone have grown from a few hundred the first year of distribution to over 12,000 per year. The number of shipments for 9 years totals almost 72,000. Although Oak Ridge National Laboratory still remains the primary routine supplier, each major USAEC reactor laboratory now produces and distributes some radioisotopes. Reactor laboratories supply only irradiated materials or simple compounds. Production of the very large number of special radioisotope compounds, radioactive pharmaceuticals, special radiation sources, and other preparations of radioisotopes, has been encouraged as a business for private enterprise. Shipments from these private secondary distributors now total more than twice that from the national laboratories. The total number of radioisotope shipments reaching ultimate users can

be estimated at around 35,000 per year.

The total activity of radioisotopes distributed per year from all U.S.A. reactor sources has increased from around 65 curies in 1947 to over 40,000 curies in 1954. The average activity of individual shipments was originally around 30 mc. Today, excluding shipments of Co 60, the average is around 350 mc. This increase in activity per shipment is largely due to industrial uses. Also reactor laboratories now serve as bulk suppliers for secondary distributors. If one includes Co 60, the average shipment now exceeds 2.5 curies.

Table III shows the approximate number of shipments and curies shipped for principle isotopes distributed in 9 years from Oak Ridge National Laboratory alone. In total curies shipped Co 60 far exceeds all other isotopes. This is mainly due to requirements for teletherapy units (now over 30 in number). Although Co 60 has many uses in science and medicine, most of the 1000 shipments of this isotope have been for technological and industrial use. Isotopes such as Cs 137, Ir 192, Po 210 and Sr 90, which are used mainly in industry, also show extensive use. I 131 and P 32 lead in number of shipments because of short life and extensive medical application.

In the future, most isotopes shown will increase steadily in use. Even greater increases can be expected in the total activity used of such isotopes as Co 60, Cs 137, H 3 and Sr 90. Industrial use of fission products from reactor fuel processing would far overshadow in activity the total curies distributed to date.

The distributed activity of C 14, 40 curies, does not seem large but in terms of normal cyclotron production, this would require about 200,000 years of cyclotron bombardment.

TABLE III

Approximate number of shipments and curies of principle isotopes in nine-year period (from Oak Ridge National Laboratory only)

Isotope	*Shipments*	*Curies*
Cobalt 60	1,000	64,300
Cesium 137	600	3,100
Iodine 131	27,600	3,000
Irdium 192	200	2,700
Gold 198	2,600	1,800
Polonium 210	120	1,200
Phosphorus 32	16,100	900
Hydrogen 3	300	700
Strontium 89-90	900	350
Carbon 14	2,100	40
Sodium 24	2,600	35
Others	18,800	800
Total	72,920	78,925

Another measure of usage is the number of papers published in scientific and technical journals. Publications resulting in 9 years through the use of U.S.A.-

produced isotopes number around 11,000. . . . Over 60% of these publications are in fields directly related to biology and medicine, including agriculture. The remainder fall mostly into the fields of science and technology. Only about 230 of the over 7,000 publications are on applied industrial use. The reason publications in the latter category are small, in spite of the increasing number of users, is because many of the uses are routine, or modifications of uses already reported. Also many new industrial uses are not reported until covered by patents. The large amount of published work on basic studies and development of techniques is of course of much benefit to industry.

In addition to domestic distribution, the U. S. A. has made isotopes available to other countries since September 1947. In nearly 8 years of such distribution, almost 4,000 shipments have been made to over 660 institutions in 46 countries. With the advent of reactors in other countries, closer to many users, most of the international needs for radioisotopes are met more conveniently outside the U.S.A. Nevertheless distribution from the U. S. A. to other countries continues to meet special needs. Shipment by air permits users all over the world to obtain most useful isotopes from any reactor laboratory.

It should be emphasized that Great Britain and Canada also have extensive programs of isotope production and distribution. If the above statistics on uses, shipments and publications were accumulated for reactor laboratories of all countries, the figures would be most impressive. They will become even more impressive in the future as world-wide use of these reactor by-products grows.

The tremendous variety of uses of radioisotopes stems from three very versatile basic principles applicable to radiation: (1) radiation affects materials, (2) materials affect radiation, and (3) radiation traces materials.

The first of these three principles, the use of radiation to affect materials, is the least exploited at present but is expected to play a large role in the future. Although radiation can have many different effects on materials, these effects all result from ionization or excitation of atoms or molecules.

Thus we find the radiation from radioisotopes applied to produce ionization of air in static eliminators, excitation of phosphorescent light sources, destruction of bacteria in foods and drugs, activation of chemical reactions, polymerization of organics, alteration of material strength and conductivity, gene changes, and therapeutic results in patients.

In the second principle of use, radiation is directed at or through

a material to gain information about the material. Here the requirements are a radioactive source, the material, and a detector to record the radiation transmitted through or reflected from the material.

All interactions of radiation with materials lower its energy or remove part of it from a beam. Thickness of material, its density, atomic number and atomic structure, have different effects on different radiations. Therefore much can be learned regarding these properties by observing their effects in absorbing or reflecting radiations.

The major applications of this principle are industrial and clinical radiography, thickness and density gaging, and analysis by radiation penetration. Other important uses include liquid-level gaging and applications where an object is revealed by its effect on a beam of radiation. The principle is also applied to industrial sorting and packaging problems.

In applications based on the third principle, radiation traces material, the radioisotope is incorporated in or carried by the substance of interest. This substance can then be located or traced, or parts of it measured quantitatively.

Radiomaterial can be traced in bulk, as in locating markers, determining fluid flow, following motion of material, detecting leaks and measuring wear and abrasion. Also, radioisotopes as tracer atoms are used to study all kinds of chemical, physical-chemical and biochemical problems. In technology, tracer uses include studies of corrosion, diffusion, detergency, catalysis, and kinetics and mechanisms of reactions.

It is obvious that each of these principles has much versatility in application. They provide a wide spectrum of uses, covering many fields of technology as well as varieties of industrial materials, processes and products.

A few specific examples of applications in each of the three categories mentioned will illustrate their usefulness.

Luminescence, an effect of radiation on special phosphor materials, provides self-luminous material for safety marking in aircraft, mines, and public buildings, for low-level illumination, and for standard light sources. Isotopes used for the purpose include polonium, tritium, strontium 90, and cesium 137. Brightness levels up to 1000 microlamberts are obtained, and a wide choice of colors can be produced. Beta-emitters are preferred for this because there is much less radiation damage to the phosphor than by alpha-emitters.

Voltage production is another application of radiation effects. This extremely small but direct conversion of radioactivity to

electricity is attracting much attention. Several types of radioisotope batteries have been developed, operating on different principles. The direct-charging type builds up a potential as negative beta particles from a radioisotope leave one electrode and collect on another. The second and third types depend on induction of a current by the contact potential difference between dissimilar materials, in one case when ions are produced in a gas by the radiation and in the other when a semi-conductor junction in silicon is energized by the radiation. In still another, the heat from radioactive decay is converted to electricity by thermocouples; in another, the light from a radioisotope-activated phosphor is converted by a photovoltaic cell. Such batteries produce minute amounts of current but are very useful, for example, in electronic circuits where long-lived, stable sources of potential are required.

Polymerization of monomers to form plastics is a radiation effect resulting from the breaking of molecular bonds. Many open bonds are formed in the path of each ionizing particle and result in active recombination into new forms and structures. A polymer produced by radiation can be quite different from a product polymerized chemically from the same material. Since no chemical is introduced as a catalyst, the product is relatively free from impurities which can alter its properties. Not only industrial products such as plastics and synthetic rubbers but blood-plasma extenders, also, can be polymerized to advantage by radiation.

A further effect of radiation on polymers is the initiation of cross-linking between neighboring molecules. Side-chain bonds are rather easily broken by radiation and immediately join with similarly opened bonds in adjacent molecules. A quite rigid, three-dimensional structure is formed, having different strength, heat resistance, and other properties than the original.

While radiation from radioisotopes may not compete with present commercial methods of producing many polymers, its ability to polymerize and cross-link gives some special materials not possible or practical by other means.

Sterilization of foods and drugs is another application of radiation effects. Although at present largely in the research stage, it will undoubtedly call for great quantities of radioisotopes in the future.

Radiation in large enough doses can destroy harmful bacteria and enzymes in a material without significantly raising its temperature. Although the necessary radiation doses cause unwanted

changes in taste and color in certain foods, others are quite unchanged and offer great commercial possibilities. Among the potential applications may be mentioned preservation of meat, poultry and fish, killing of trichina in pork and of insects in grain, inhibiting of sprouting and spoilage in stored onions and potatoes, extending shelf life of canned meats and vegetables, and pasteurization of dairy products.

While a good estimate of sterilization cost cannot yet be made, it seems that it will be in the neighborhood of one to seven cents per pound. Future costs depend in large measure on feasibility and economics of obtaining large usable quantities of fission-product isotopes from spent reactor fuels.

Sterilization of drugs and other medical supplies seems to present fewer problems than that of food. Side effects are not as important and radiation processing can assure "guaranteed" sterilization while avoiding disadvantages of high-pressure steam sterilization. Judging from effectiveness of experimental facilities, operating costs would compare favorably with present ones.

The ability of radiation to supply information by reflection from or transmission through material has proved a boon to industry. Most of the routine industrial applications are based on this principle of material affecting radiation.

Radiography, for example, took a great stride forward when strong sources of gamma-ray emitting isotopes such as cobalt 60 and iridium 192 became available. Radiographic testing of numerous materials and products became more convenient and economical. Many small foundries now maintain a routine radiographic inspection of their castings. Inspection teams can move along a new pipeline in the field, radiographing weld after weld in rapid succession.

Radioisotopes are supplying another long-felt need in industry with their ability to give rapid information as to thickness and density of material. The beta-gage, employing beta particles, is the most commonly known radioactive device for this purpose. Beta-gages are now completely established as a routine thickness monitoring instrument, especially in sheet processing industries with products such as steel, aluminum, and other metals, plastics, paper, cloth, and floor covering. The rate of installation of these gages is increasing rapidly.

Thickness gages are not limited to the use of beta-emitters, appropriate gamma and x-ray emitters being employed in gaging larger thicknesses of sheet materials. For example, a gamma-ray density gage has been developed

to record continuously the density, and thus the weight, of sugar during a refining process. A product or process material can be in containers or flowing in closed conduits and still the gamma-ray density gage can "see" it through the walls.

The great variety of materials which industry needs to measure is matched by the variety of radiations among the available radioisotopes. Near one extreme is the use of 67-kev beta radiation from nickel 63 to measure ink-film thicknesses on a lithographic press and, near the other, is the use of 1.3-mev gamma rays from cobalt 60 to gage sheet steel.

Reflection type gages have been developed which take advantage of the backward scattering of radiation. They require only one side of a material to be accessible, radioisotope source and detector being mounted side by side. Using gamma sources, such instruments allow routine monitoring of internal corrosion in process tanks, logging the types of strata in an oil-well bore, and measurement of soil density. Beta-ray reflection gages permit measuring of thin films on base material of different atomic weight, such as gold plated on copper or plastic over steel. Wear tests on traffic-marking paint, for example, have been made with such a gage which measures the paint film within a ten-thousandth of an inch.

A great advantage of radioisotope gages, in addition to their convenience and accuracy, lies in their ability to measure a material without contact. Swiftly moving strips of delicate and perhaps still moist or sticky product can be measured, where formerly production machinery had to be stopped while the strip was measured. In the manufacture of coated abrasives, for example, one company has long been using a series of five beta-gages in one production process. These measure the thickness and amount of backing stock, adhesive layers, and abrasives as they are applied to the product passing swiftly through various stages. The resulting product is superior in uniformity and much saving in raw material is realized.

The use of these gages leads naturally to automatic control of the processing equipment. Such automatic control is now fairly well established in processing of adhesive tape, steel, cigarettes, rubber sheet, and paper and in plastic calendering. Such diversity of application is a good illustration of the widespread usefulness.

The third category of radioisotope use in industry, radioactive tracer techniques, do not employ as many total curies of activity as will the production of radiation effects, and are not as numerous as the penetration and reflection techniques. They nevertheless in-

clude many of the most interesting applications. Moreover, they can match the others in usefulness and economic value.

Many tracer techniques in industry have reached the routine operational state, usually where an object or material is to be followed or located or to be indentified among others of its kind. For example, radioactive material is injected between successive shipments of petroleum products through a cross-country pipeline and identifies the change-over by activating a continuous counter at a later switching terminal. Losses due to uncertainty as to region of mixing have been sharply reduced.

The petroleum industry is an outstanding example in its solving of technological problems with tracer isotopes. Fluid flow is of prime importance from the initial drilling of a well to final delivery of refinery products. Pumping a suspension of radioactive particles into a well and then logging the radioactivity along its length reveals leaks, open formations, and permeable zones. The latter zones are of interest as oil-bearing or oil-thieving areas or as pathways for conduction of water in pressuring an oilfield for secondary recovery.

Radioactive tracers are added to cement, used to blockoff unwanted zones, to evaluate its position and extent, and are added to pressurizing water to determine its entry into other wells. They are also added to the acid used to treat oil-bearing limestone strata for greater productivity, to tell by means of a counter lowered into the well when the acid is being forced into the proper zone.

The moving-marker technique for cross-country pipeline shipments is applied also in tracing movement of batches of oil through complex piping patterns in the refinery. Also, the rate of flow of solid catalyst particles in petroleum cracking plants is monitored routinely by timing the passage of an occasional radioactive bead.

Underground gas-storage fields utilize a porous formation many hundreds of feet down, sealed above and below by impervious strata and reached by drilling wells. When a leak occurred recently, short-lived radioactive argon 41, emitting 1.3 mev gamma rays, was introduced through a well into the reservoir. Gas leakage, especially around loose fitting well casings, could then easily be traced with detectors lowered through the casings.

This is but one example of the power of radioisotopes to detect leaks of all kinds which are a constant source of trouble in industry. A tracer amount of radioisotopes can be introduced into gas or liquid systems and then either detected as it emerges from a leak or followed, despite inter-

vening structure, by means of its gamma radiation.

One of the most widely applicable and rewarding uses of tracer radioisotopes is the wear and corrosion studies. Radioactivity introduced into a machine part, cutting tool, or furnace lining is also present in the particles later worn or corroded from the surface. Thus the amount or rate of removal is quickly and accurately measured by the activity appearing in the lubricating oil or furnace product.

In another type of wear test a material applied to a surface is made radioactive. After wear, the amount of radiation shows how much material remains, and thus its resistance to wear. Many protective coatings are evaluated in this way.

Benefits are derived however by almost any industry adapting radiotracers to the solution of its problems. As an example in the pharmaceutical industry, rapid analysis for the vitamin B 12 content of large heterogeneous mixtures is performed by adding a small radioactive-labeled sample of the vitamin and using the isotope dilution method. As an example from a widely different technology, the organic chemicals used in water flotation of mineral ores to cause a desired mineral to separate out are evaluated by tracer techniques. With labeled chemicals it is possible to determine the conditions for and extent of adsorption on any particular mineral.

As tracers of molecules, rather than of material in bulk, radioisotopes are widely used in the study and control of chemical processes. Citing the petroleum industry again as an example, a great amount of research is being done on hydrocarbon chemistry. Carbon 14, deuterium, and tritium come naturally as tracers into this work. They have been of inestimable value in elucidating the mechanisms involved in alkylation, polymerization, catalytic cracking, and many other important reactions.

Further development of the versatile industrial uses of isotopes will be limited only by human ingenuity.

The total economic value of isotope utilization is very great but difficult to assess exactly. It can, however, be measured by success in (1) saving time of personnel in basic and technological research, (2) increasing speed in acquisition of knowledge, (3) saving materials and labor in manufacturing, (4) improving performance and durability of manufactured products, (5) increasing agricultural productivity, (6) decreasing losses from food spoilage, and (7) improving the health of the public.

Although it is not possible to assign quantitative or monetary

value to all these benefits, certain examples and generalizations will help give an over-all appraisal.

Because the supply and time of scientific and technical personnel are limited, saving of their time is more important than the salaries involved. But even more important is earlier application of results. The sooner problems are solved, the sooner benefits can be realized.

Diamonds Become Transistor Crystals

➤ All blue diamonds and some others, when heated to a few degrees above ordinary temperatures, have been found to transmit electric current in one direction. They act like crystals of the semi-conducting metal germanium, now in demand for transistors in electron circuits.

Studies of the electric properties of diamonds, revealing a new classification, IIb, for the kind which are semi-conductors, were described by Dr. J. F. H. Custers of the Diamond Research Laboratory, Johannesburg, South Africa. Other diamonds of similar type, classified as IIa, are electrical insulators, conducting no current at all, Dr. Custers reported in the journal *Nature*.

Up to now diamonds have been divided by physicists into two classes, called I and II, according to the pattern of X-rays scattered by their crystal structure. Impurities in class I diamonds are believed by some physicists to account for the differences between the two classes, while the crystals of class II are believed to be purer and more regular. Impurities would therefore not account for the difference in conductivity of the two kinds of class II diamonds found by Dr. Custers. He found, however, that semi-conducting diamonds may be due to slight defects in the crystal lattice.

Chemical Controls Parasitic Weed

➤ Chemical attack is proving effective in controlling the parasitic weed, dodder, a major pest in alfalfa fields of the West and especially troublesome to alfalfa seed growers.

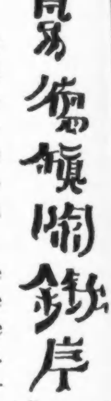
Spraying with the chemical herbicide CIPC just as alfalfa begins to grow in the spring delays dodder sprouting by about a month, the USDA found. This delayed sprouting, in turn, cuts the number of dodder plants that grow to maturity, form seeds and re-infest the fields the following year. Holding back the emergence of dodder also nets a better alfalfa seed crop, the U. S. Department of Agriculture reported.

Dodder is a parasitic weed which fastens itself to helpless host plants, using their nutrient materials that they manufacture to feed itself.

Ancient Vase Picture
Tells Story of Hero

Porcelains Show the History of China

by Hope Willis Rathbun



➤ There are porcelain furnaces whose fires have glowed continuously in China for a thousand years. Their history unites the early chemical craftsmanship of the potter, the skill of the painter, who mixed the colors and drew the pictures which decorate the vases fired in those furnaces, and the story-telling art which has kept alive the half-legendary lore of warrior chiefs of early times.

Curiosity about the gigantic figure of a bearded Chinese warrior plunging down a mountainside on a spirited horse led to a search through Chinese history to identify the man portrayed on vase after vase in museum collections of rare old porcelains.

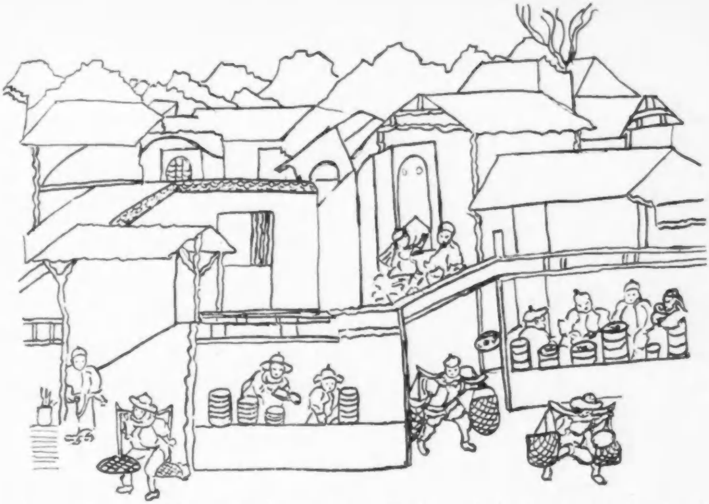
Peaceful life in sheltered gardens and farflung caravan routes of ancient China altered with ruinous barbarian invasions and hopeless defeat in the ancient chronicles through which one follows the legends of the hero, Kuan Yü.

History of the art and the science of making pottery also comes into the story. The word pottery covers all the kinds of ware which are made of clay. These range from the coarsest clay vessels, through glazed stoneware which is finer and of firmer texture, and up to the finest grades of porcelain, which approach the hardness of glass.

Europeans and the Chinese do not agree as to the point where true porcelain begins. For Europeans, porcelain must be so hard that it cannot be scratched with a knife and must show translucence when it is held against the light. The Chinese depend upon the musical tone given off when porcelain is lightly struck.

In the art of China, porcelains have played a greater role than in that of any other country. Their beginnings were far back in history. It is believed that had the pottery of the Shang dynasty, in the eleventh century B.C., been fired at a higher temperature, there would have been porcelain nearly two thousand years before it actually came into being in the T'ang period, 618-907 A.D.

While pottery was made in a



▸ POTTERIES *at Ching-te-chen, originally founded about 621 A. D., in the province of Kiangsi, China, as they are shown in a medieval manuscript book. The art of porcelain making has been carried on there continuously ever since. It is said that the fires of these kilns have never gone out, in spite of the troubled years of China's history. Products of Chinese porcelain kilns often illustrate the exploits of historical characters, like the vase shown on the back cover of this issue.*

number of places in China, the great ceramic center was at Ching-te-chen in the province of Kiangsi. For more than a thousand years its kilns have cast a veil of smoke over the great city, and from them have flowed, sometimes in a trickle, more often in full stream, the most beautiful porcelains the world has known.

Pottery making at Ching-te-chen was begun soon after 621 A.D. when the barbarian tribes of southeastern China were driven from the region. Its production has continued there even to the present day.

From the period of T'ang, 618 - 907 A.D., came the first polychrome wares; green and yellow glazes used together. Earlier potteries were glazed but with a single color. Few of the T'ang vases have survived. They are known chiefly by later copies.

During the Sung dynasty, 960 - 1127 A.D., were produced and ever since have been justly prized, the exquisite almost transparent

bowls and dishes of blue-green or nearly white celadon, fluted or incised in lotos or scroll designs. One rare piece shows a four-clawed dragon chasing a flaming pearl.

Porcelain is made of very fine white clay, or kaolin, combined with a ground feldspathic stone and fired at a very high temperature. The transparent glazes which vitrify in the kiln are of feldspar. Metallic compounds furnish the colors. Lead and iron are common. Copper oxide used under differing conditions can produce many different colors, including blue. The blue in the famous Ming ware, however, is due to cobalt. The purest cobalt material used during the Ming dynasty came by caravan from Persia and was called "Mohammedan blue".

It was in the Ming dynasty, 1368-1644, that porcelains came to full flowering. The imperial potteries were established beside the earlier ones at Ching-te-chen and thereafter a steady flow of the rarest porcelains of all kinds were sent to the Ming emperors, changing with their tastes, but those for the palace always of superb quality.

The "blue and white" of early Ming has never been surpassed. When fired it ranged in color from a smoke blue to clear cut brilliancy. On vases, cups or dishes, blue dragons spring and rush among waves or clouds, a scholar or poet with his attendant sits reading in a garden or wanders through a landscape with pilgrim staff. Ceremonial cups in which to offer wine upon an altar show the eight Buddhist emblems or the five sacrificial offerings. Not only is the sight entranced by color and clear drawing, but the "feel" of the glaze in the hands gives the thrill of its quality to the connoisseur.

In the reign of Cheng-hua, 1465-1487, the court took on more frivolous note and from Ching-te-chen came "the five-colored porcelains" never again quite equalled, and the famous "chicken cups" enamelled in brilliant colors of cock and hen and chicks under chrysanthemums or peonies, the slender cup stems worthy of the delicate hands of Wan-kuei-yei, the beautiful consort of the Emperor. In later Ming there seems to have been on plates, vases, cups and bowls an elaboration of detail in the drawing and of story telling from legend and history and scenes of romance. This was intensified in the next dynasty.

The Mings fell in 1644 before the Manchus (Mongols), more by the dissensions among their own generals than by the strength of the enemy. The Imperial potteries were destroyed and for a number of years the pottery kilns showed little fire at Ching-te-chen. But with the Ching dynasty, the Manchus were soon firmly in control

and by the reign of K'ang Hsi, 1662-1722, the potteries were again in full flame. From then on Ching-te-chen poured forth the perfection of its porcelain for the emperor and the court, and only slightly lesser beauty to the Chinese officials. Often they sent them far afield for by now Europeans had become avid for them.

In the National Gallery, Washington, D. C., the Widener Collection has a room of beautiful porcelains, either marked or attributable to the reigns of K'ang Hsi, 1662-1722, and Yung Cheng, 1723-1736. There are large "sang de boeuf" vases, almost cruel in their deep brilliant reds, boxes and small straight necked vases of the "peach bloom" glazes, rose and crushed rose shading to apple green, and the wonderful "claire de lune", misty grey of so high a lustre that one longs to stroke the gleaming surface. On the black and white "hawthorne" vases birds fly through flowering branches of plum trees above fantastic blue rocks. While the dainty bordered plates of the "famille rose" picture quail with peonies or ladies and playing children in gay gardens, done with almost incredibly minute and delicate drawing. There are porcelain figures of dragon dogs, of the Eight Immortals, of the Goddess of Mercy, Kwanyin. Other pieces are even more pictorial showing scenes from the lives of the poets or sages or heroes of romance.

One of these "picture" vases is of particular interest in that it shows a scene from the life of Kuan Yü, one of the greatest of Chinese heroes who fought in the Wars of the Three Kingdoms, 168-244 A.D.

The vase is of "palace" quality and presumably made at Ching-te-chen for the emperor and, though unmarked, attributable to the K'ang Hsi period. It is described in the catalogue of the Widener collection of porcelains as a "famille verte" military beaker vase, of pellucid white glazed foundation sustaining a military subject in brilliant "famille verte' colors." The subject is inspired by picturesque scenes from the famous historical romance of the San Kuo Chih Yen-i, or Romance of the Three Kingdoms, written in the 13th century and beloved ever since by millions of Chinese. It is the great classic of Chinese fiction.

It was this vase, shown on the back cover of this issue of CHEMISTRY, which inspired this study of Chinese history. The spirited figure on the horse could only be a hero famous in the history of the country and the legends of his people, for his likeness seemed to be reproduced in many Chinese works of art. Was he really a personage of history, and, if so, in what period of China's troubled history did he carry on his daring exploits? After

reading the Romance of the Three Kingdoms, the dashing horseman could be identified as Kuan Yü, champion of the Third Kingdom.

In actual life Kuan Yü was probably a rough soldier, but in the San Kuo and in the minds of the Chinese he is the invincible warrior, the soul of chivalry, the supberb fighter for Liu Pei and the glory of the house of Han. In 1594 he was deified as Kwan Ti, the protective god of war, and is worshipped even today.

The period of the story, which follows history rather closely, is the breakup of the Han dynasty beginning about 168 A.D. The Empire was divided into the Three Kingdoms, and the triangular fight between the Three Kingdoms kept the country in a ferment for nearly a hundred years.

Revolt against the Han dynasty was led by Ts'ao Ts'ao, all powerful regent at the court, who murdered the emperor, kept his brother in subjection, and assumed the royal prerogatives. He ruled the First Kingdom. The Third Kingdom stood faithful to the Han. Its leaders was Liu Pei, who fought Ts'ao Ts'ao with bitter hatred throughout his life, regarding him as no more than a rebel.

In the second of the Three Kingdoms, the Suns were in control. They played the other leaders off against each other, sometimes in league with one or the other, sometimes as their enemies. The Suns were clever diplomats but too often false friends and treacherous allies.

With Liu Pei in the Third Kingdom fought his sworn brothers Kuan Yü and Chang Fei. These are the three heroes of the San Kuo. The romance opens with their famous brotherhood oath in the Peach Orchard as sworn upholders of the house of Han. It follows their picturesque exploits and good or evil fortunes through many years of fighting. The characterizations are sharp and the incidents vivid.

Liu Pei cared for a city of people in a dark hour of his fortunes though they clogged his army's movements and endangered his soldiers' lives. He said, "These people have trusted me, I cannot desert them. We must find food and shelter for them."

Chang Fei's explosive angers were often a danger, usually coming at the worst possible moment when diplomacy with the enemy was the only card to play.

But Kuan Yü is still the great hero. Even a learned Chinese scholar may still thrill to read of him as he gallops across a mountain pass on his war horse, the Red Hare, or, feigning flight before a superior number of the enemy, turns suddenly to annihilate them or send them in headlong retreat.

Liu Pei died at fifty, beloved of all his kingdom but sad and brokenhearted that his many victories had never been quite enough, knowing that the Han would never be restored to power. Chang Fei was assassinated by one of his own followers. Kuan Yü met his death by execution at the orders of a general, who had captured him by ruse, and offered him protection if he would turn traitor. Kuan Yü responded with scorn and called him "a red bearded rat". He probably knew that phrase sealed his death warrant.

The palace vase in the Widener collection represents one of his many encounters with the enemy. In full armor, on a black horse, he gallops through a rugged defile in the mountains and turns in his saddle to thrust an immensely long spear at three pursuing horsemen. From above on the mountainside Ts'ao Ts'ao looks down on the fight and beyond Liu Pei and Chang Fei also watch their champion's prowess. In the sky a red sun indicates full noon. History and the San Kuo end the story of the Han in defeat and gloom but on the vase in the National Gallery, Kuan Yü seems still alive, a figure worthy of the legends that have gathered round his name for seventeen hundred years.

On the Back Cover

➤ CERAMIC *art and history are combined in this ancient vase portraying the Chinese hero Kuan Yü leaping from a mountain crag. Search for the meaning of such spirited scenes on museum porcelains led a Washington artist, Mrs. Rathbun, through mazes of Chinese history, shown on the products of kilns which have been in continuous use for a thousand years. Kuan Yü had two staunch friends, who may be glimpsed in the vase picture, behind him among the mountain peaks. Overhead, near the top of the vase, the sun shines down on the usurper.*

Mold Products Preserve Food
Fatten Livestock, Help Plants

Antibiotics Increase Usefulness

➤ ANTIBIOTIC-BURGERS may be the next addition to the menu of the corner "greasy spoon."

The presence of small amounts of aureomycin will keep hamburger meat from souring several days longer than meat kept under refrigeration alone, Dr. A. Z. Palmer of the University of Florida Agricultural Experiment Station at Gainesville has discovered.

Even when kept at low temperatures, hamburger meat has a bad habit of souring in a couple of days, due to bacterial action. So Dr. Palmer reasoned that a pinch of aureomycin might defeat the food-spoiling germs.

In experiments he found that as little as ten parts of the antibiotic to a million parts of hamburger kept the meat in good condition for at least ten days, while untreated samples were soured in from four to ten days. Both batches of meat were kept under proper refrigeration during the tests.

The process is not commercially usable yet, he cautions, since the effects of the aureomycin on humans eating the meat has not yet been thoroughly studied. Some people, for instance, are highly allergic to the antibiotic.

It may be that any harmful effects from the aureomycin might be eliminated by proper cooking of treated meat, Dr. Palmer suggests, making the antibiotic more generally useful as a preservative.

New Antibiotic Fights Fungi

➤ A NEW, powerful antibiotic that attacks fungus diseases of man and useful plants has been discovered in organisms that live in the soil of the Philippine Islands.

Laboratory experiments have shown the new antibiotic, called filipin, to be effective against at least 13 human pathogenic fungi. And what may become even more important in the long run, filipin strikes at a long list of fungi that destroy man's food crops.

Filipin has shown no activity against bacteria in the tests, however.

Experimental work on the new antibiotic was a joint project between the horticultural and chemical departments of the University of Illinois, at Urbana, and the Upjohn Company of Kalamazoo, Mich. Drs. Alfred Ammann, David Gottlieb and Herbert E. Carter of the University and Drs. George B. Whitfield and Thomas D. Brock of the Upjohn Company reported the research in the Jour-

nal of the American Chemical Society.

Filipin appears to belong to a new family of antifungal agents, the scientists said, though it closely resembles another fungicide, fungichromin, which was recently announced.

The antibiotic was isolated from a previously unreported soil fungus from the Philippines which has been named Streptomyces filipinensis.

The scientists found that tomato seeds and pea seeds received protection from common seed-rotting fungi after being soaked in filipin. Gray leaf spot, a semi-tropical blight of tomatoes, was partially controlled with a spray of crude filipin, too, in laboratory experiments.

New Antibiotic in Pakistan

➤ DISCOVERY of a new antibiotic in an organism obtained from East Pakistan earth was announced by Drs. K. Ahmad and M. F. Islam of the University of Dacca, East Pakistan, in the British scientific journal, Nature.

The antibiotic has been named Ramnacin after the place, Raman, where the organism producing it was discovered. This organism is a member of the streptomyces family. This is the family of organisms between molds and fungi which also produced one of the first antibiotics, streptomycin.

Ramnacin is a stable antibiotic showing activity against a number of bacteria including some staphylococcus and streptococcus germs, and a couple of fungi.

Increase Livestock Production

➤ A BIT of antibiotic added to their feed will net an average growth increase of 10% to 20% in swine, Dr. T. J. Cunha of the University of Florida, Gainesville, Fla., reported to the first International Conference on the Use of Antibiotics in Agriculture.

With the addition of antibiotics, it takes 20 pounds less feed than formerly for each 100 pounds a hog puts on, Dr. Cunha told scientists from 14 nations gathered in Washington to report progress and plot future plans for this revolutionary tool to help feed the world's increasing population —antibiotics in agriculture.

The growing family of antibiotics, which began with penicillin, first helped man practically to check many of his most dreaded diseases. Then scientists discovered that antibiotics fed to animals result in faster, healthier growth besides combating diseases of livestock. More recently, antibiotics have been used successfully to fight plant diseases.

The conference on antibiotics in agriculture was sponsored by the U.S. National Academy of Sciences and the National Research Council. Thirteen nations besides the United States sent scientists to take part in the meeting.

Dr. Hjalmar Clausen of the

Royal Veterinary and Agricultural College, Copenhagen, Denmark, asked the conference for international cooperation on experiments with antibiotics on swine production. He said that research on 1,998 pigs in Denmark showed that the amount of dressed meat obtained compared to the weight of the live hog was stepped up significantly following the use of antibiotics in the feed.

Chickens, too, benefit from doses of antibiotics. Dr. James McGinnis of Washington State College, Pullman, Wash., told the conference there is good circumstantial evidence that the good effects come from the work of antibiotics on bacteria in the chickens' intestines.

Dr. McGinnis suggested that nutritional deficiencies weaken the birds, causing them to be susceptible to growth-retarding diseases. The addition of antibiotics, then, would work against the bacteria causing disease, allowing the chickens to grow more efficiently.

Work Many Ways

➤ Antibiotics added to livestock feed are able to make animals grow faster and more efficiently, at great savings to farmers. How do these "miracle" chemicals work?

According to Dr. C. A. Baumann, biochemist with the University of Wisconsin, there are at least four ways that antibiotics act as growth promoters.

1. They suppress germs in the animals which may be too mild to cause serious disease but which can act to slow growth.

2. They encourage the production of useful vitamins by certain organisms which live in the animal's intestines.

3. They cut down on the number of intestinal bacteria which use vitamins that might be utilized by the animals.

4. They cause a thinning of the intestinal walls of the antibiotic-fed animals, which allows better absorption of vitamins and other nutrients in the body.

Dr. Baumann told the International Conference on the Use of Antibiotics in Agriculture that different animals may use the antibiotics in different ways. Experiments on vitamin-deficient rats showed that the encouragement of vitamin production and cutting back on bacterial competition for nutrients were the most important effects of antibiotics, he said. On the other hand, the disease-suppressing effect seems to be the most important job for antibiotics in boosting chick growth.

To supply an inch of water to a garden measuring 60 by 70 feet, or about $\frac{1}{10}$ acre, takes about 2,700 gallons, or 25 times as much as the average household uses daily per person.

Aniline Yellow

by Burton L. Hawk

➤ Here is an experiment in progressive synthesis which will test your skill as a home chemist. By "progressive synthesis" we mean the preparation of one compound and then using this to prepare another, and so on until the final product is obtained. Obviously, it is important to prepare each compound most carefully so that it will work sucessfully in succeeding syntheses.

We will prepare two compounds, diazoaminobenzene and aniline hydrochloride, and then combine them to form the third, aminoazobenzene. Hence, all of the experiment is divided into three parts:

1.Preparation of Aniline Hydrochloride

Mix together in a beaker 5 cc. of aniline with 5 cc. of water. Slowly add 10 cc. of concentrated hydrochloric acid, with stirring. Heat the mixture gradually until it just begins to boil; then allow to cool. Filter off the crystals which form rapidly as the liquid cools. Finally, carefully dry the crystals. This can best be done by heating on an improvised steam-bath. Scrape the crystals from the filter paper onto a watch glass. Place the glass over the top of a beaker half-filled with water. Heat the water to boiling so that the steam will rise and heat the watch glass. Arrange the glass so that the excess steam escapes through the spout of the beaker. When dry, cover the crystals and save for use later on.

2. Preparation of Diazoaminobenzene

Place in a 125-cc. Erlenmeyer flask a mixture of 2½ cc. concentrated hydrochloric acid in water. Add 2 cc. of aniline and stir until dissolved. Then cool the solution to about 25-deg. (If necessary immerse the flask in a container of cold water). Keeping the temperature between 25 and 30 degrees, carefully add one gram of finely powdered sodium nitrite in small portions. Shake the solution after each portion. A brown colored precipitate forms. Allow to stand for five minutes, then add a solution of 2½ grams crystallized sodium acetate dissolved in 10 cc. of water. Again, shake thoroughly and allow to stand for 15 minutes. This time a dark yellow precipitate is obtained. Filter it off and wash with cold water. Now it is necessary to dry the product. This must be done *very carefully* as diazoa-

minobenzene explodes when heated to 150 degrees. We suggest using the steam bath described above for this purpose. Heat until the compound is *nearly* but not entirely dry, then let it stand in a warm but not hot place until it is entirely dry. The product is to be used immediately in the final step. Do not attempt to store it.

3. Preparation of Aminoazobenzene

Now take one gram of the dry aniline hydrochloride prepared in part 1 along with the entire amount of diazoaminobenzene (which should be close to two grams) prepared in part 2 and dissolve both in 5 cc. of aniline in a test tube. Heat the mixture for about 30 minutes at 30 degrees and then for an additional 30 minutes at 45 degrees. Insert a thermometer in the test tube and stir frequently throughout the heating. Of course, only a small amount of heat is required to maintain the temperature. Be careful not to overheat. Next a solution of 6 cc. concentrated hydrochloric acid in 18 cc. of water is added with stirring, and the mixture cooled. Aminoazobenzene hydrochloride separates out of solution. Filter it off and wash with dilute hydrochloric acid. Dissolve the product in 100 cc. of hot water to which a little hydrochloric acid has been added. Filter again and add 5 cc. of concentrated hydrochloric acid to the filtrate. Cool, filter off the precipitate and wash once more with dilute hydrochloric acid. This compound, aminoazobenzene hydrochloride, is known as Aniline Yellow. It colors silk and wool an intense yellow. You can try it by dipping the material in a hot solution of aminoazobenzene hydrochloride which has been made slightly acid.

The free base, aminoazobenzene, can be obtained by adding one gram of the hydrochloride to 4 cc. of alcohol. Add ammonium hydroxide until it dissolves. The base is precipitated by adding water and can be obtained by filtering.

Those faithful readers who have been following our "Organic Reactions" series can now include *diazotization* in the list. This was the process used to prepare the above compound. The reaction was first used by Griess in 1858 and has since become most important in synthesizing many compounds, particularly dyes. Diazonium salts are prepared by the reaction of a salt of a primary aromatic amine with nitrous acid at low temperatures. In the dry state they are usually explosive and hence are not often separated from aqueous solutions. They behave somewhat like ammonium salts and even ionize in water.

Resonance Acceleration Devices
Described by Russian Physicist

Acceleration of Charged Particles

Part 2.

by VLADIMIR I. VEKSLER

The Synchrotron

The synchrotron is a resonance electron accelerator. Its essential advantage over the other cyclical accelerator, the betatron, which we have already mentioned, is that it permits a striking reduction in the power and weight of the electromagnet, the poles of the magnet being made in the shape of a narrow annular ring. This is possible because at the velocities at which the laws of relativity come into play, the mechanism of acceleration automatically keeps the electron orbit radius constant.

An essential part in the movement of electrons in cyclical machines, in contrast to that of heavy particles, e.g., protons, is played by the characteristic electro-magnetic radiation emitted by the electrons.

The Soviet physicists Pomeranchuk and Ivanenko, and Pomeranchuk and Artsimovich, first called attention to the fact that this radiation upsets the operation of the betatron and sets a limit, of the order of several hundred MeV, to the energy thus attainable.

In contrast to the betatron, the resonance electron accelerator, the synchrotron, possesses the remarkable characteristic that the appearance of electro-magnetic radiation does not upset the mechanism of acceleration since the radiation losses are automatically compensated. This compensation comes about because the radiation losses reduce the energy of the electron and consequently shorten the length of its revolutions. Therefore the equilibrium phase is shifted into the region of high accelerating voltages and some additional (by comparison with the absence of radiation) energy is imparted to the particles, thus compensating the losses*.

A number of fundamental problems of the physics of elemental particles could be explained if electrons and gamma-rays were available with much greater energies of the order of several thousand MeV. It seems to me that it should now be possible to build a synchrotron designed to produce an electron beam with an energy of 5-10 thousand MeV.

* Of course, this compensation can only go on until the point is reached at which the radiation losses per revolution exceed the maximum energy gain of the particles during the same period.

There is, however, a limit to the energy attainable in the synchrotron. It is interesting that this limit is determined entirely by the quantum nature of radiation. This phenomenon, it seems, may serve as a first example of how often the laws of quantum mechanics that govern the microcosm lead to results of importance in engineering practice.

The Soviet physicists Sokolov and Ternov investigated, by quantum mechanics, the influence exerted by radiation on the trajectory of an electron moving in a magnetic field. The result of their work was rather unexpected. It turned out that at very high energies the radiation sharply increases the range straddle of the electron in a radial direction. This effect, which might be called the "spread" of the trajectory, can also be quite easily produced and explained on the basis of the ordinary theory of the movement of particles in accelerators, if we simply allow also for the statistical character of the radiation. From this point of view, the emission of a quantum with an energy of hw_i is accompanied by abrupt changes in the radius of the orbit in which the electron normally moves, Obviously, the amplitude of the oscillation also changes to a slight extent in the process. The statistical compounding of these random jumps results in the spreading of the trajectory. The position here is analogous to the oscillations of a pendulum subjected to random impulses on its point of suspension. The "spread" referred to increases relatively quickly with time (i.e. with the energy of the electron) and at energies of the order of several thousand MeV reaches a size comparable with the width of the synchrotron ring. The following example is typical of the magnitude of the quantum effect mentioned; when electrons are accelerated up to an energy of 5,000 MeV in a synchrotron with a radius of 15 metres, the "spread" of the trajectory reaches a value of the order of several metres in one second. Therefore, electrons with very high energies can be produced only with small acceleration periods.

The Phasotron

The principle of phase stability has made it possible to achieve very great successes in the acceleration of ions. There are two types of accelerators for heavy particles based on the application of this principle. One of them is very similar to the ordinary cyclotron, and is called in the Soviet Union a phasotron*; the other is an unusual combination of synchrotron and phasotron, which we call a synchrophasotron.

The phasotron differs from the cyclotron in that in it the frequen-

* In England and America this accelerator is called a synchrocyclotron.

cy of the electric field accelerating the particles is modulated in time.

In both cyclotron and phasotron the trajectory of the particles is an outward spiral. In the phasotron, however, the pitch of this spiral is very flat and at high energies amounts to only a few hundred microns. This is because at velocities of frequency modulation approaching one hundred cycles per second the equilibrium energy gain acquired by the particles each time they traverse the phasotron accelerator gap rises to the order of 10^4 eV. The flat pitch of the spiral makes it difficult to extract the particles from the phasotron. Usually only about 0.1 per cent of the particles can be successfully extracted. The effective extraction method developed by Dmitriyevski and others on the Soviet phasotron made it possible to extract 5 per cent of a beam of protons accelerated to an energy of 680 MeV.

About ten phasotrons are now in operation in various parts of the world, producing particle beams with energies of several hundred MeV. In the Soviet Union in particular is the biggest phasotron in the world, constructed under the direction of Meshcheryakov, Yefremov and Mints, giving proton beams with energies of 680 MeV. The magnet of this hugh accelerator weighs about 7,000 tons, the poles being 6 meters in diameter. The gap in the vacuum chamber is 60 cm wide. The accelerator can operate at various impulse frequencies, usually generating 80 impulses a second. The current of accelerated protons may be as great as 0.3 micro-amperes.

The phasotron, used in general to produce Pi - mesons, is very effective, but the second accelerator I mentioned earlier, called a synchrophasotron, which combines certain features of both the synchrotron and the phasotron, is much more effective for accelerating ions to energy levels near the upper limit.

The Synchrophasotron

In the Soviet Union, "synchrophasotron" is the name given to an accelerator in which a magnetic field increasing with time is used to control the trajectory of particles, acceleration being effected by an intermittent electric field, the frequency of which also increases with time.

The accelerators built in America under the names of the Bevatron and the Cosmotron, and in England under the name of the Proton Synchrotron, are synchrophasotrons in so far as the principle on which they work is concerned.

So far as I know, the use of the synchrophasotron for accelerating heavy particles was first proposed by Oliphant.

Crane was the first to call attention to the fact that variation of the frequency of the electric field according to a rule, determined by the strength of the magnetic field in the gap of the magnet of the accelerator, allowed the orbit radius to be kept constant at all energies of the accelerated particles.

In this case, the pole of the magnet of the synchrophasotron can be made in the shape of a narrow annular ring. In all the big accelerators, e.g. the Bevatron, Cosmotron etc., the radial width of the ring is about 5-10% of the value of the equilibrium radius of the orbit. This shape of pole makes it possible to reduce the weight of the magnet itself and the amount of power required to operate it many tens of times.

Modern synchrophasotrons are colossal engineering projects. Some idea of the scale of the works necessitated by the construction of such accelerators may be gleaned from a few data about the biggest synchrophasotron in the world, in the USSR, which, is almost complete. The accelerator magnet consists of four quadrants with an average radius of 28 metres, separated by straight gaps each 8 metres long. The magnet weighs about 36,000 tons. The reactive power needed to operate it is 140,000 kVa. To facilitate exhaustion, the chamber has been made double, with divided vacuum.

The protons will be injected with the help of a linear accelerator with an energy of 9 MeV. The protons are accelerated in the chamber for 3.3 seconds, gaining on an average of 2,200 eV of energy per revolution in two accelerating systems. The accelerating systems consist of stacked tubes each with a maximum effective voltage of 5 kV.

The frequency of the accelerating field is increased by 7½ times, and its value is harmonized with the instantaneous strength of the magnetic field to an accuracy of up to 0.1 per cent. Having completed 4.5 million circuits of their orbit and traveled 2.5 times the distance from the earth to the moon, the protons will reach an estimated energy of 10,000 MeV.

Several problems connected with the operation of this synchrotron (injection, resonance, noise and modulation of the magnetic and accelerating fields, observation of the beam etc.) have been studied under the direction of Professor V. A. Petukhov on a working model producing protons with an energy of 180 MeV.

Despite the great successes obtained in the study of elemental particles with the aid of accelerators, we are still far from the limiting energies possessed by cosmic-ray particles. I would like,

therefore, in conclusion, to dwell on the problems, so intensively discussed during the past few years, of the construction of giant synchrophasotrons designed for accelerating protons to energies of the order of 50,000-100,000 MeV.

Prospects of Accelerators

In the ordinary synchrophasotron the magnetic forces which, as it were, hold the particles in their orbit and prevent their destruction on the walls of the chamber, are in fact very weak. It is easy to show that they are determined by the gradient of the magnetic field in the gap between the poles of the magnet. In ordinary synchrophasotrons this gradient is generally insignificant; accordingly, the quasi-elastic forces are weak and the range of oscillations of the particles is great. As a result, the dimensions of the gap between the poles must be relatively great. If the dimensions of the accelerator are increased, as they must be if we wish to increase the limiting energy of the particles, the width and height of the gap must themselves be correspondingly increased. Working on these lines, with contemporary experimental accuracy and the technical possibilities of industry, it will be hardly possible to reach energies exceeding 10,000 to 20,000 MeV. To continue along this path seems not only senseless, but ruinous.

In 1952, Livingstone, Curant and Snyder proposed a completely new and extremely ingenious way of solving the problem. The essence of their idea was a sharp increase in the magnitude of the forces constraining the particles to keep to their orbit.

For this it is necessary to make the gradient of the magnetic field in the gap between the poles of the synchrophasotron very large, both radially and vertically. Unfortunately, if the gradient of the magnetic field is chosen to ensure vertical stability, then the radial movement becomes completely unstable, and *vice versa*.

Livingstone and his colleagues called attention to the circumstance that, by using a series of sectors with opposite gradient signs, general stability of movement could be achieved. This solution of the problem makes possible a sharp increase in the magnetic forces acting on the particle, and so reduces by from 10 to 15 times the size of the gap of the electro-magnet required.

This method is called the strong focussing method. Unfortunately, it seems, nothing in this world can be got for nothing. The increase in focussing forces obtained by this method automatically increases the liability of particles to every form of perturbation.

In addition, another difficulty arises. At a certain rather high energy, usually called the critical energy, strong-focussing accelera-

tors lose their auto-phasing capacity. This entails danger of the loss of accelerated particles. Still, it seems that all these difficulties can be overcome. An increase in accuracy in making and assembling electro-magnets will obviously enable us to avoid dangerous perturbations in the movement of the particles. Rabinovich and Kolomenski, and also Vladimirski and Tarasov have proposed an ingenious way of avoiding the critical energy.

In 1953, the Soviet physicists Petukhov, Rabinovich and Kolomenski suggested an interesting modification of the strong-focussing method based on the use of a constant magnetic field.

Quite recently a similar suggestion was published by Simon, Kerst and others.

Thus, in many countries intensive work is at present being carried out on the design and study of accelerators for the production of energies approaching the upper limit of the scale.

In the Soviet Union, plans are being made under the direction of Vladimirski to build strong-focussing accelerators for high energies. It is also proposed to avoid the critical energy by using a new method of regulating the frequency of the accelerating field (correlation with the gradient of the magnetic field) and so on.

It seems to me, however, that no real progress in the production of ultra-high energies is to be expected from the use of such accelerators. It is a well known fact that the radius of the magnet of any cyclical accelerator is related by a simple equation to the particles obtained in such a machine, namely: $W = 300\ HR$.

As contemporary magnetic materials do not allow a field of more than 10,000 to 20,000 oersted to be produced, any increase in energy calls for a proportional increase in the radius of the electro-magnet, which obviously, even in strong-focussing accelerators, in practice restricts the upper value of the energy to 50,000-100,000 MeV.

In so far as the potentialities of the usual proven methods appear to be exhausted, new ones will have to be looked for. For instance, we could make great progress if we could devise means of creating ultra-powerful magnetic fields, or of considerably increasing the maximum voltage of the electric field in linear accelerators. It is true that even ultra-powerful magnetic fields will not lead to a substantial increase in the upper limit of the energy of electrons, as this limit is in practice determined by radiation.

Therefore, my personal opinion is that we must seek out completely new approaches. There are several possibilities I think.

But it would be premature to discuss the problem here, as it still needs very thorough examination. I do not doubt, however, that experimental physics will succeed in solving this problem too, and that we shall learn how to create artificial particles with enormous energies of the order of 10^{12} and 10^{13} electron-volts.

Synthesize Large Vitamin Fragment

➤ PART OF the biggest piece of anti-anemia vitamin B-12 has been synthesized by scientists of Merck and Co., Inc. The synthesis is considered a key both to the structure of the vitamin and its complete synthesis and also to more knowledge of how it acts in the body.

The vitamin, made up of 183 atoms of six different kinds, is produced by fermentation methods similar to those used for production of penicillin and other antibiotics.

The synthesis, by Drs. Karl Folkers, Frederick A. Kuehl and Clifford H. Shunk, was announced by Dr. Folkers at the International Congress of Biochemistry, Brussels, Belgium.

Hardy Germ Feeds on Cyanide

➤ A GERM that thrives on potassium cyanide, deadly poison to man, animals and most forms of life, has been discovered.

Experiments were made at Britain's Water Pollution Research Laboratory to determine the fate of potassium cyanide in sewage being treated. This resulted in the isolation of the bacterium that was capable of growing on silica gel medium containing only the poisonous chemical as a source of nitrogen and carbon.

The scientists, G. C. Ware and H. A. Painter, found that ammonia is produced from the cyanide by the growth of the organism, but the fate of the carbon in the chemical has not yet been traced.

The organism has been provisionally classed among the Actinomycetaceae, in which the organism that produced streptomycin is also placed.

The organism consists of Gram-positive branching filaments approximately a micron in diameter, some of which are broken up into bacillary segments. These grow as a hard, white and powdery colony which gets as large as a millimeter in diameter after incubation for seven days at 28 degrees Centigrade. Some of these colonies can utilize more than half a milligram of cyanide a day.

Inventions of Interest
In Novel Applications

Power From Sun and Sound

Copies of patent specifications may be obtained for 25 cents each from the Commissioner of Patents, U. S. Patent Office, Washington 25, D. C. Order by number and enclose money order, coins or Patent Office coupons, but not stamps.

French Sun Furnace

➤ THE INVENTION that has made possible the world's largest sun furnace, nestled high in the French Pyrenees has been awarded a patent by the U. S. Government.

Felix Trombe, director of the National Center for Scientific Research in Paris, was granted U.S. patent No. 2,707,903 for inventing giant composite mirrors capable of trapping the sun's energy. To achieve this feat, M. Trombe designed a composite mirror made of several hundred little mirrors. Each of the little mirrors, he found, if made of pliable glass, could be shaped by permanent mechanical fingers attached to its back. This would then form each into the shape intended for the composite mirror itself. It is possible, he states, to use thinner glass plates and, owing to the effect of the mechanical stresses applied to these mirror plates, they keep their shape much more easily than flat elements, despite the action of wind, vibrations or thermal expansion.

The French sun furnace, in operation for over two years, consists of two great mirrors, one of which is a 105-square-yard parabola, a product of M. Trombe's invention. The modern solar energy laboratory in the mountains is capable of generating a temperature of 5,432 degrees Fahrenheit. French scientists are using the sun furnace to produce and study some minerals which are made at temperatures too high for ordinary furnaces.

The invention's patent rights were assigned by M. Trombe to the National Center in Paris.

Sonic Wave Powdering

➤ PULVERIZING dry solid matter by subjecting it to intense sound waves as it travels in a high speed gas stream is the invention of Joseph Lecher of Basel, Switzerland, who was granted patent No. 2,709,552.

Mr. Lecher states that the production of ultra-fine particles having the size of three microns and even smaller can be achieved by whirling the fluid stream of particles at high speed in a radial

path. The particles knock against each other and the cylinder walls and are also subjected to intense vibratory shock waves. He assigned the rights to his disintegrator to the Microcyclomat Company of Minneapolis, Minn.

Detergent

➤ GARAGEMEN, auto mechanics and home tinkerers will be pleased to learn that a detergent has been invented that is designed for removing oily material and sludge from the hands and other parts of the body.

The composition consists of metal alkyl sulfates obtained by the sulfation of a distillation fraction of shale oil, a filter, and a binding agent, such as clay. The addition of a refined mineral oil itself, states Daniel Stewart of Broxburn, Scotland, helps removal of tarry matter. The detergent is also suited for removing mineral oils or sludge from painted surfaces without scratching them. Made into a paste, the detergent proved effective even if the dirt contained weak acids or metalic salts.

The invention was awarded patent No. 2,708,185. Mr. Stewart assigned the patent rights to Scottish Oils Limited of Glasgow, Scotland.

Oil Recovered With Gas

➤ OIL CAN BE recovered from "exhausted" wells by cycling a high pressure gas mixture through the subsurface porous formation. The invention makes possible oil recovery from underground reservoirs, estimated to be as much as 50% of the original amount for some wells.

In operation, an injection well is sunk into the formation near the production well. A high-pressure gas is then forced through the formation toward the production well. The high-pressure gas, states the method's inventor, Joseph C. Allen of Houston, Tex., must be in the form of a retrograde-enriched mixture, such as carbon tetrachloride or benzene, capable of dissolving the heavy parts of oil. The retrograde-enriched gas must also have a critical temperature below that of the reservoir.

Mr. Allen found that for subsurface temperatures above 100 degrees Fahrenheit, methane, ethane and ethylene do the job and when the temperatures are above 206 degrees, propane can be used. The inventor points out that use of the retrograde-enriched, high-pressure gas is particularly effective where secondary recovery attempts, such as water flooding and normal gas pressuring, have been exhausted.

Receiving patent No. 2,708,481, Mr. Allen assigned the patent rights to The Texas Company of New York.

Citrus Fruits Extractor

➤ A FACTORY-SIZED orange juice squeezer extracts the juice, keeping it free of the bitter peel oils, saves and presses the peels for their valuable products, and does the same with the seeds. It has received patent No. 2,708,627.

Working mechanically and automatically, the extractor eliminates the refining process heretofore needed to separate the peel oils from the juices, and at the same times saves the waste products from laborious chemical treatments.

The invention of Harry A. Toulmin, Jr., of Dayton, Ohio, the extractor produces juices free of offensive oils; flavedo from the pulp in granular form for stock and human food; the peel oils for vitamins and pigments; the seed oils for industrial finishes and poultry food. He assigned the patent rights to the Commonwealth Engineering Company of Ohio.

Low Sodium Milk

➤ A LOW SODIUM content milk, rich in proteins, has been developed for persons suffering from kidney trouble and high blood pressure, as well as those requiring a low sodium diet before and after operations.

Called "high protein deionized milk," it is substantially the same as natural milk in flavor and carbohydrate and protein content. During the deionization process, one part of an anion exchange resin, which removes the acidic parts from salts, and from 0.8 to 1.33 parts of a cation exchange resin, which removes the metal parts from salts, reduce the natural milk's minerals as much as 80%. Protein, at least 50% by weight, is then added to the deionized milk.

Capable of being powdered, the deionized milk is the invention of Edwin G. Stimpson of Sayville and Lloyd K. Riggs of Oakdale, N. Y. Awarded patents Nos. 2,708,632 and 2,708,633, the inventors assigned them to the National Dairy Research Laboratories, Inc., of Oakdale, N. Y.

Water Content Determiner

➤ THE AMOUNT of moisture in bushels of grain, and the water content of cement or textiles can be determined rapidly and accurately by an invention that received patent No. 2,708,387.

The invention of two government scientists, the water-content determiner employs tracer studies using stable isotopes rather than radioactive isotopes. A known amount of the material to be tested is immersed in a mixture of deuterium and hydrogen oxides. A rapid spectroscopic determination of the ratio of these two oxides gives the measure of the original water content.

The measuring method was invented by Herbert P. Broida of Bethesda, and Harold J. Morowitz, Kensington, Md.

Book Condensations

SCIENCE AND ITS BACKGROUND—H. D. Anthony—*Macmillan,* (*St. Martin's Press*) 2d ed., 337 p., illus., $4.00. Telling the story of science in its background of history.

HIGHLIGHTS OF SCIENCE—Harry Bates Brown—*Vantage,* 213 p., $3.50. A general book on science for the beginning student and the general reader rushed for time.

ATOMIC AND NUCLEAR PHYSICS –Robert S. Shankland – *Macmillan,* 529 p., illus., $7.75. With some emphasis on the historical point of view but not slavishly chronological.

THE BIRTH AND DEVELOPMENT OF THE GEOLOGICAL SCIENCES—Frank Dawson Adams – *Dover,* 506 p., illus., paper, $1.95. An unabridged republication of this work first published in 1938, which draws on the works of 500 early writers including Aristotle and Humbold.

STEINMETZ: Maker of Lightning – Sigmund A. Lavine – *Dodd, Mead,* 241 p., illus., $3.00. The biography of an inventive genius.

THE URANIUM PROSPECTOR'S GUIDE – Thomas J. Ballard and Quentin E. Conklin—*Harper,* 251 p., illus., $3.50. Designed to give in non-technical language the basic information necessary to the prospector, miner or layman who is interested in uranium raw materials. The authors were formerly with the Exploration Division of the Atomic Energy Commission.

SIGNIFICANCE OF INDUSTRIAL WASTES – Richard D. Hoak – *Mellon Institute,* 9 p., paper, free upon request direct to publisher, 4400 Fifth Ave., Pittsburgh 13, Pa.

ESSENTIALS OF BIOLOGICAL AND MEDICAL PHYSICS – Ralph W. Stacy and others—*McGraw-Hill,* 586 p., illus., $8.50. Based on four years of teaching biophysics at Ohio State University.

MATERIALS FOR NUCLEAR POWER REACTORS—Henry H. Hausner and Stanley B. Roboff with foreword by T. Keith Glennan – *Reinhold,* 224 p., illus., $3.50. A guide for scientist and materials engineer as well as for investors and students.

AN INTRODUCTION TO CHEMISTRY – Howard L. Ritter—*Wiley,* 649 p., illus., $6.50. Presenting chemistry as a cultural study without neglecting practical chemical information.

MODERN PHYSICS – John C. Slater – *McGraw-Hill,* 322 p., illus., $5.50. A text for advanced undergraduate students of science and engineering stressing, not mathematics, but the history of development of ideas tied together with enough theory to make it comprehensible.

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➤ ETHANOLAMINES are used in a number of industrial applications, including gas treating (H_2S and CO_2 removal), corrosion inhibition, as textile intermediates and softeners, detergents, cosmetic and toilet goods, emulsifying soaps in waxes, polishes and coatings, in pharmaceuticals and as rubber chemicals. The technical staff of the Jefferson Chemical Co., Box 303, Houston 1, Texas, will help investigate the possibilities of their line of ethanolamines in other manufacturing enterprises.

➤ STUDY of the pure components of natural gas by the Institute of Gas Technology is complete with the publication of Research Bulletin No. 26, "Physical-Chemical Mixtures." Other bulletins of the Properties of Ethane - Nitrogen series already published are No. 17 (1952) on methane-nitrogen mixtures and No. 22 (1953) on methane-ethane. Copies of the new bulletin may be obtained from the Institute of Gas Technology, Information Service, 17 West 34th St., Chicago 16, Ill.

➤ THE METAL POWDER Association has just issued "Data Sheet No. 4", titled "Standards, Specifications and References for Metal Powders and Metal Powder Products". The material is grouped according to publications pertaining to metal powders, metal powder bearings, structural parts, electronic cores, electrical contacts and others, the latter devoted chiefly to cemented carbides. Official designations are listed, along with pertinent differences between standards issued by different organizations but based on the same subject. Copies are available on request from the Metal Powder Association, 420 Lexington Ave., New York 17, N. Y.

➤ FLUOROCARBON polymer products noted for their resistance to chemical attack and other corrosive conditions are described in a new 16-page booklet, "KEL-F Fluorocarbon Oils, Waxes and Greases", available from the M. W. Kellogg Co., P.O. Box 469, Jersey City 3, N.J. Among the applications suggested are hydraulic pumps, potting and sealing waxes, damping fluids, heat transfer media, permanent lubrication for instruments and clocks, and synthetic lubricant blends.

➤ ABITOL, a primary, monohydric alcohol derived from rosin, is used in alkyd resins as well as in adhesives, fixatives, hot-melt coatings, oil and wax additives and surfactants. For a new technical booklet describing the properties and applications for Abitol write to Hercules Powder Co., Wilmington 99, Del.

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Additional Gift Names may be added on other paper and attached to this order

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